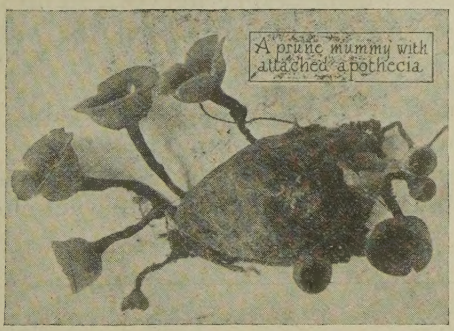
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1410

CONTROL OF BROWN-ROT OF PRUNES AND CHERRIES IN THE PACIFIC NORTHWEST



UNITED STATES DEPARTMENT OF AGRICULTURE
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BROWN-ROT is found annually in the prune and cherry orchards of the lower Columbia and Willamette Valleys, both as a blossom infection and a rot of the fruit.

In most years the losses are small, but occasionally, when unusually damp weather prevails, there is a serious epidemic, which causes the loss of a large percentage of the crop, sometimes by destroying the young fruit in the blossom stage but more often by the development of rot as the fruit approaches maturity.

Fall and winter plowing and thorough cultivation during the blooming season greatly decrease the blossom infection.

Thorough pruning aids in the control of brown-rot and is otherwise valuable in producing the crop.

For the complete control of brown-rot, spray the trees just before the blossoms open, just after the petals have fallen, when the husks are shed, and three to five weeks before harvest. The last application has been found particularly valuable on prunes.

Lime-sulphur has caused considerable injury to foliage on both prunes and cherries. Bordeaux mixture and self-boiled lime-sulphur sometimes have had a dwarfing effect on the sweet-cherry fruit.

Washington, D. C. Issued March, 1924

CONTROL OF BROWN-ROT OF PRUNES AND CHERRIES IN THE PACIFIC NORTHWEST.

By D. F. Fisher and Charles Brooks, *Pathologists, Office of Fruit-Disease Investigations, Bureau of Plant Industry.*

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OCCURRENCE OF BROWN-ROT.

BROWN-ROT of prunes and sweet cherries annually attacks orchards in the lower Columbia and Willamette Valleys. In

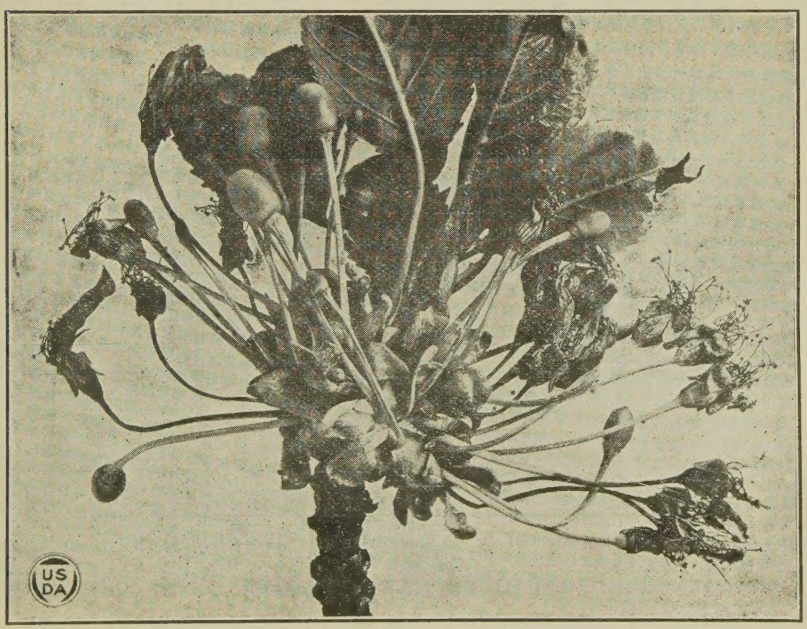

Fig. 1.—Brown-rot infection on young Napoleon cherries, from Felida, Wash., in 1916.

most years the attacks are not severe enough to attract general attention, but occasionally the constantly present disease breaks out into a serious epidemic that causes the loss of a large percentage of the crop. The destructive phases of the disease have taken two

forms—one an infection of the blossoms and the other a rotting of the fruit as it approaches maturity.

BLOSSOM INFECTION.

Blossom infection is often overlooked, yet it represents the first foothold the disease gets in the orchard in the spring. The trouble usually starts as a browning or blackening of the under calyx lobe and may later spread to such an extent as to involve the whole flower and part or all of its stem. The blackened parts usually persist for a considerable time, furnishing a ready means of distinguishing the diseased blossons from those that are yellowing from a lack of pollination or from starvation. (Figs. 1, 2, 3, and 4.) In some years there is but little blossom infection, while in others from a third to two-thirds of the blossoms are destroyed by the brown-rot fungus, the severity of the epidemics varying greatly with the weather conditions and with the cultural and spraying practices.

FIG. 2.—Young Italian Prunes affected with brown-rot. Collected at Felida, Wash., April 9, 1915.

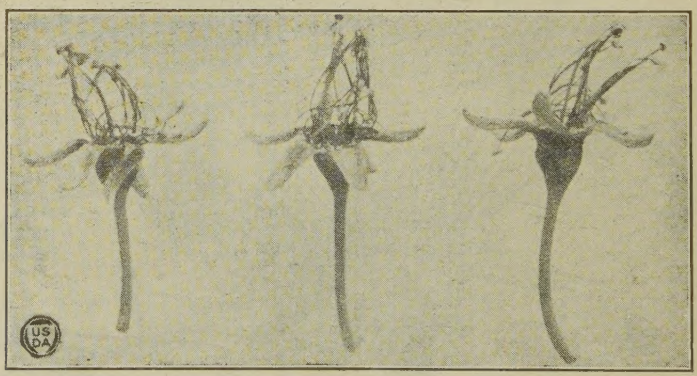

FIG. 3.—Healthy prunes collected at the same time and place as those shown in Figure 2.

FRUIT INFECTION.

The prunes and cherries may become infected with brown-rot at any time during the season, but they are much more susceptible as they approach maturity. If damp and showery weather prevails during harvest time, there is likely to be a rapid spread of the disease. (Figs. 5 and 6.)

In some years, as much as a third of the total crop is destroyed while still on the trees; and even under average conditions the losses in the more neglected orchards are usually heavy. When dry weather prevails throughout the harvesting period, the orchard losses are small, and brown-rot becomes a menace only when the fruit is shipped or is delayed at the drier or cannery.

FIG. 4.—Yellow and apparently unpollinated prunes collected at the same time and place as those shown in Figures 2 and 3.

THE BROWN-ROT FUNGUS.

The brown-rot fungus[1] lives through the winter on the rotten and mummied fruit that is left on the tree or on the ground. The prunes and cherries that are partly buried in the trash or soil are most favorably situated for carrying the disease over.

The fungus develops a mass of tissue within the rotten fruit, and about blooming time sends up urn-like growths known as apothecia. (Figs. 7 and 8.) The top of the apothecium is exposed above ground, the length of its stem varying with the depth at which the mummy is buried. The stem sometimes attains a length of 5 inches. At

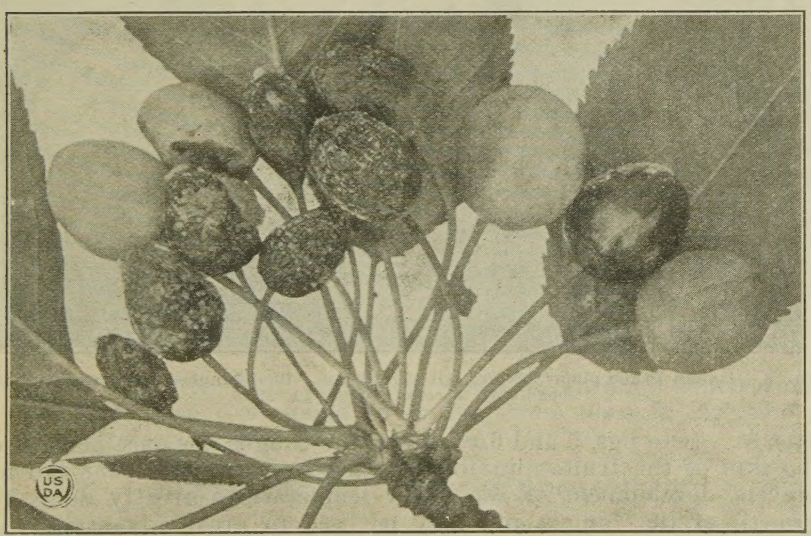

FIG. 5.—Immature Napoleon cherries affected with brown-rot. May 25, 1915.

first the enlarged top is cup shaped, but later it flattens into a more or less disklike body. If the mature apothecium is jarred, spores are thrown out like a puff of smoke. These spores are carried to the blossoms by the wind, and they germinate there to start the

[1] *Sclerotinia cinerea* (Bon.) Wor.

fungus anew. (See figs. 1 and 2.) The blossom is killed, and a few days later powdery ash-gray masses may be found on its surface.

These powdery masses are made up of summer spores that serve to spread the disease in the orchard.

If the weather is damp, these summer spores germinate on the surface of the prune or cherry, sending out threads that penetrate the skin and start the rot.

When a particular rot is well advanced, ash-gray spore masses appear on its surface, which serve in turn for a further spread of the

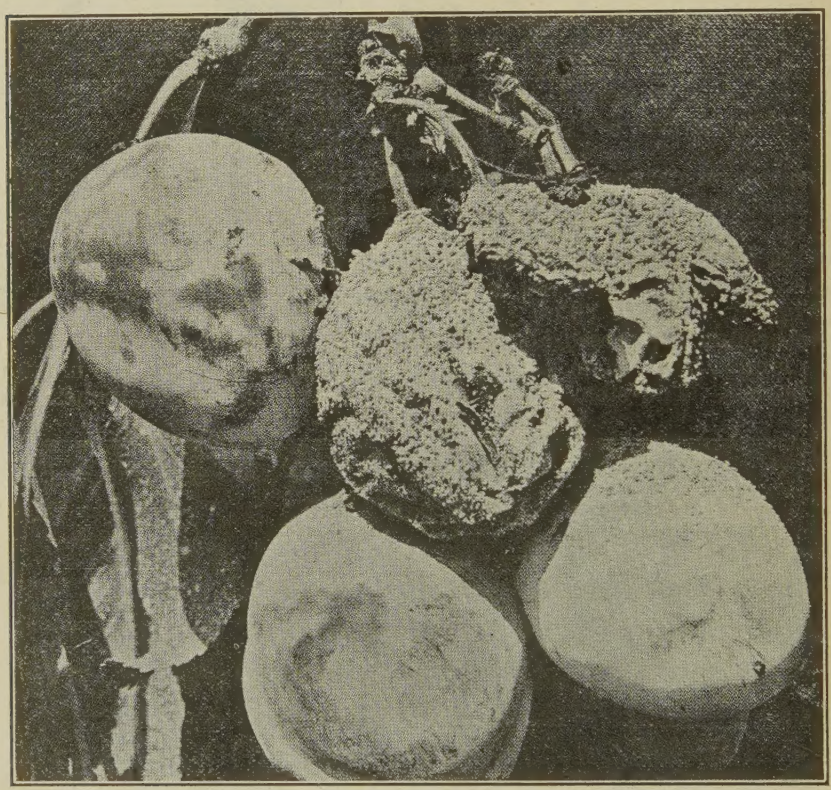

FIG. 6.—Italian Prune plums affected with brown-rot. Photographed when the fruit was beginning to color, August 11, 1915.

disease. (See figs. 5 and 6.) When the fungus has once penetrated the skin of the fruit, spraying or other orchard treatment can not prevent development of rot. Low temperatures greatly delay the growth of the fungus and may be used to great advantage with the harvested fruit as a preventive for losses from brown-rot.

PLOWING, CULTIVATION, SOILS.

Plowing and harrowing are of great value in the control of brown-rot. Fruit that is deeply buried is not likely to produce apothecia. Harrowing, in the early spring and during the blossoming season is likely to disturb the partly formed apothecia and prevent their

further development. Orchards that are not plowed or cultivated until after the blossoming season, as is frequently the practice, usually have an abundance of apothecia, while those that are plowed and cultivated before that time are usually practically free from them, except in tree rows or other unplowed areas. Apothecial clusters sometimes have been found, three or more to the square foot, in the uncultivated tree-row strips and entirely absent in the cultivated parts of the orchard.

Different soils are not equally favorable to the development of apothecia. They occur on moist bottom lands more abundantly than on well-drained hills. They are hardly ever found on coarse, "red-shot," clay soils.

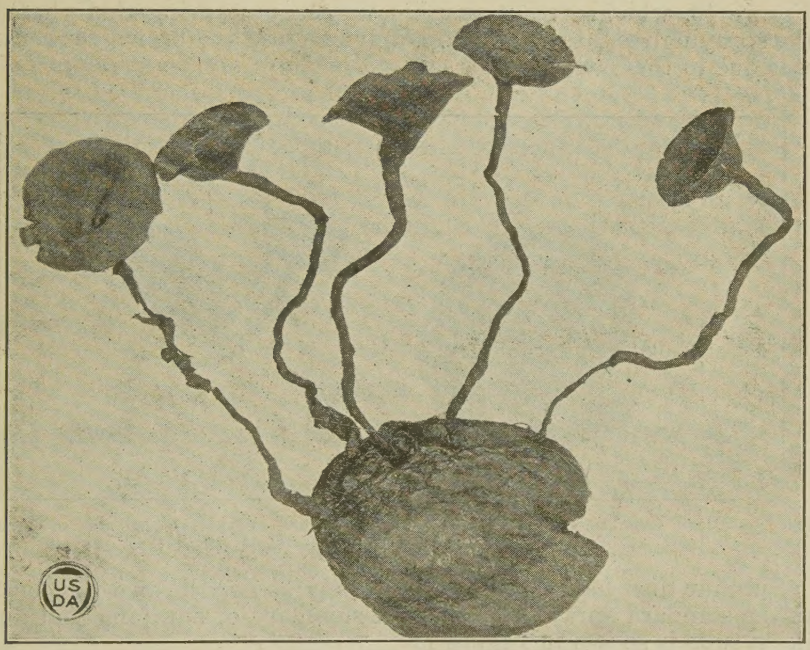

FIG. 7.—Italian Prune mummy and attached apothecia, from the orchard of A. W. Moody, Felida, Wash., April 9, 1915.

Orchards free from apothecia, made so through cultivation or otherwise, have been found to be free from blossom infection and usually relatively free from brown-rot.

SPRAYING FOR PRUNE BROWN-ROT.

The conclusions in regard to spraying are based on experiments carried out in the Italian Prune orchards of A. W. Moody at Felida, Wash., during the years 1915 to 1918, inclusive, and in the Italian Prune and Agen Prune (*Petite Prune*) orchards of L. T. Reynolds at Salem, Oreg., in 1916 and 1919. These experiments will be reported in detail in a forthcoming department bulletin.

Blossom infection was always reduced by early applications of spray. In some cases the resulting benefits were apparently lost in

the June drop, but in others the sprayed trees carried a much heavier load at picking time than those that were not sprayed.

During the five years covered by the experiments, brown-rot of the fruit was never severe in the orchards in which the experiments were made, but the contrasts between the sprayed and unsprayed trees showed that the spray applications had been very efficient in holding the disease in check. A summary of the five years' results is shown graphically in Figure 9. It will be seen that the sprayed fruit had only about one-third as much brown-rot at harvest time as the unsprayed and that in the shipping and holding tests it developed only one-fourth as much disease as the unsprayed fruit.

A spray a few weeks before harvest was found to be particularly valuable for controlling the brown-rot. This fact is brought out in Figure 10, which gives a graphic summary covering this phase of the spraying results. Approximately one-half the brown-rot control was due to this late spraying.

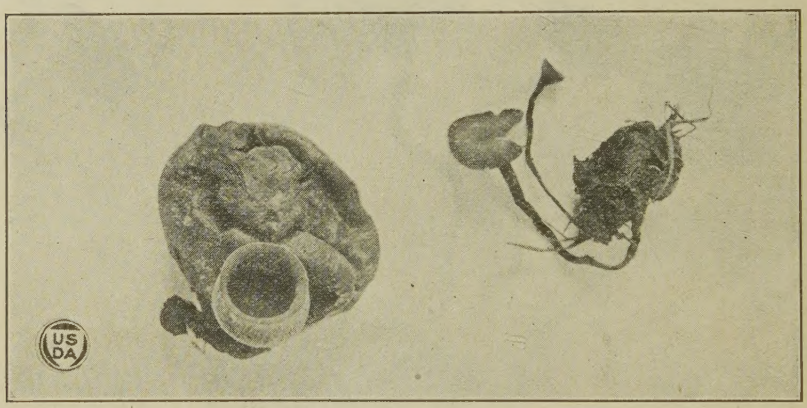

FIG. 8.—Black Republican cherry mummy and attached apothecia, from the orchard of L. T. Reynolds, Salem, Oreg., March 31, 1916.

Sulphur dust has given approximately as good brown-rot control as the standard spray materials. A summary of spraying and dusting results is shown in Figure 11.

RECOMMENDATIONS FOR THE CONTROL OF BROWN-ROT OF PRUNES.

The prune brown-rot problem in the lower Columbia and Willamette Valleys is apparently not so much a matter of finding remedies as a question of how much money and effort the grower is justified in spending and is willing to spend on a disease that is more or less erratic in occurrence. There seems to be no doubt that the remedial measures that have become fairly well established in sections of the eastern United States, where brown-rot is more constant in its occurrence, would fully meet the situation in the humid sections of the Pacific Northwest if consistently applied. The question is really one of balancing the cost of insurance against the possibility of loss and determining the most economic procedure.

Cultivation can be recommended as a good investment. Plowing in the fall, winter, or early spring and frequent harrowing before and during the blooming season will decrease the number of apothecia.

Many of the orchards of this section need heavier pruning. A proper thinning out and cutting back of the top encourages renewal of fruiting wood, gives a better set of fruit, and helps to prevent brown-rot by admitting the sunlight and by giving an opportunity for thorough spraying.

The application of dust or spray three to five weeks before harvest can be recommended as an insurance fully justified by average conditions. The advisability of spraying just before the blossoms open, just after the petals have fallen, and just after the husks are shed may vary with the orchard and the season; but applications are timely in all cases where brown-rot is likely to become a menace.

The effectiveness of any spray material depends very largely on the thoroughness of the application, the fineness of the spray, and the manner in which it covers and adheres. The smooth, waxy skin of the prune renders it practically impossible to effectively cover and protect the fruit with any liquid material without the addition of a spreader.

Various spreaders have been tested for use on prunes, and of these the resin-fishoil soap and casein have proved most satisfac-

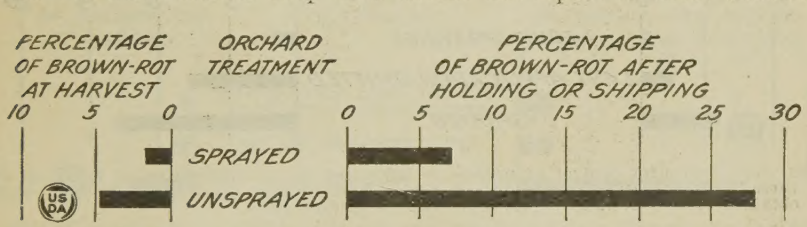

FIG. 9.—Comparison of the average development of brown-rot on sprayed and unsprayed Italian Prunes in 11 different spraying and holding experiments.

tory. The resin-fishoil soap causes considerable foaming in the tank and is somewhat objectionable on this account. It is more troublesome to make and more expensive than the casein. For directions on preparing spreaders, see page 11.

Both lime-sulphur and Bordeaux mixture caused more or less spray injury, the former in particular. Bordeaux injury was always associated with rainy weather following the spraying, while lime-sulphur injury was associated with hot weather. Because of the possibility of serious spray injury lime-sulphur is not recommended for prunes. Self-boiled lime-sulphur, 8–8–50, is to be preferred to Bordeaux mixture. For directions on preparing sprays, see page 8.

RECOMMENDATIONS FOR CONTROL OF BROWN-ROT OF SWEET CHERRIES.

The conclusions in regard to spraying sweet cherries are based on experiments in 1915 to 1919, inclusive, in the orchards of L. T. Reynolds at Salem, Oreg., on the Napoleon (*Royal Ann*), Black Republican, and Lambert varieties. The results will be reported in detail in a forthcoming department bulletin.

Under the climatic conditions of the lower Willamette Valley sweet cherries were found susceptible to spray injury. Lime-sulphur frequently caused some injury to the foliage, and Bordeaux mixture and self-boiled lime-sulphur usually had a more or less dwarfing effect on the fruit.

The addition of resin-fishoil soap to the spray material tended to decrease the cracking of the fruit that sometimes occurs in showery weather.

Early spray applications reduced the amount of blossom infection (fig. 12), but the set of fruit was usually so nearly evened up in later "drops" that there was little difference in yield between the sprayed and unsprayed trees.

During the five years that the tests were continued practically no brown-rot was seen in the orchards at picking time, and any conclusions as to the merits of spraying have to be based on the holding quality of the fruit. The summary of results from 18 different holding tests given in Figure 13 shows that the sprayed cherries developed less than a third as much brown-rot as those unsprayed.

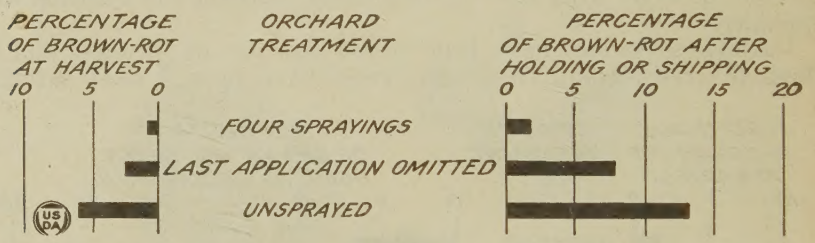

FIG. 10.—Brown-rot control of prunes as influenced by an application of spray or dust three to five weeks before picking time. The diagram shows the average results obtained from 7 orchard experiments and 11 holding tests.

The last spraying was the most important one, with reference to development of brown-rot on the harvested fruit. A summary of the tests on this point is given in Figure 14.

The five years' investigation has not furnished a basis for definite recommendation in regard to brown-rot of cherries as it occurs in the lower Willamette Valley. Fall or winter plowing and early spring harrowing, both in the cherry orchards and adjacent prune orchards, undoubtedly would be of value in reducing the amount of disease on the blossoms. Spraying has greatly reduced the amount of brown-rot developing after picking. But in view of the small percentages of rot that have occurred in the orchards, and the prevailing custom of disposing of all the sweet cherries at the cannery, it may be a question whether systematic spraying would pay.

PREPARATION OF SPRAYS.

SELF-BOILED LIME-SULPHUR.

The standard self-boiled lime-sulphur mixture is composed of 8 pounds of fresh stone lime and 8 pounds of sulphur to 50 gallons of water. Any finely powdered sulphur—flowers, flour, or commercial-ground sulphur—may be used.

To get the best action from the lime, prepare the mixture in rather large amounts, at least enough for 200 gallons of spray, which calls for 32 pounds of lime and 32 pounds of sulphur.

Place the lime in a barrel. Pour on enough water to almost cover it, which probably will take about 6 gallons. As soon as the lime has well started to slake, add the sulphur, after first running it through a sieve to break up the lumps and mixing it to a slush with a little water. Stir the mixture at intervals, and add more water, 3 or 4 gallons, as needed, to form a moderately thick paste. Cover it and allow to stand four to five minutes. If on slight stirring it is found to be growing thinner and softer and the light sulphur yellow changing to a brownish color, the process is finished, and cold water should be gradually stirred in.

If after four or five minutes the mass has not softened or darkened distinctly on testing with the paddle, it should be immediately covered and allowed to stand another four or five minutes. Repeat this until the mixture is softer and darker in color, and then check the action by adding cold water.

The mixture is then ready to be strained into the spray tank, diluted with water, and used.

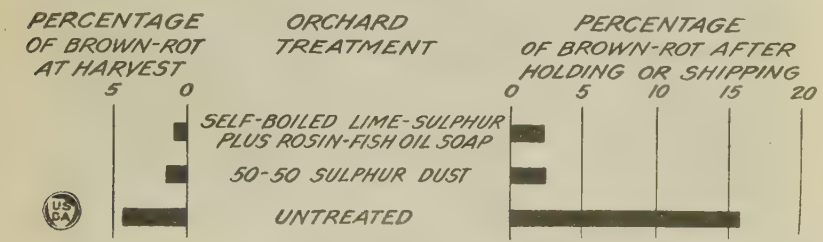

FIG. 11.—Comparative results from spraying and dusting in a four-year test on prunes.

If the mixture is allowed to remain hot for 15 or 20 minutes after slaking is completed, part of the sulphur probably will go into solution, combining with the lime to form sulphids. The resulting spray has greater fungicidal value and is preferred for use on prunes but may be injurious to peach foliage. The stage at which the cold water should be added to stop the cooking varies with the lime. Some limes are so sluggish in slaking that it is difficult to obtain enough heat from them to cook the mixture at all, while other limes become intensely hot on slaking, and care must be taken not to allow the boiling to proceed too far. After using self-boiled lime-sulphur, it is important to thoroughly wash the spray tank and pump to remove the sediment.

BORDEAUX MIXTURE.

Bordeaux mixture is made of copper sulphate (bluestone), lime, and water. As ordinarily used for brown-rot of prunes, it consists of 4 pounds of copper sulphate, 4 pounds of stone lime, and 50 gallons of water.

It is convenient to make up stock solutions of copper sulphate and lime in 50-gallon lots.

A stock solution of copper sulphate is made by dissolving it at the rate of a pound of the copper sulphate to a gallon of water. 50 pounds of copper sulphate being placed in a clean gunny sack and

suspended just beneath the surface of 50 gallons of water in a barrel (one with wooden hoops being preferable). This will dissolve in 24 hours, or sooner if hot water is used. A gallon of this stock solution then contains 1 pound of copper sulphate.[2]

The lime is prepared by slaking a definite quantity of stone lime (it should be at least 90 per cent pure) in a measured quantity of water. A smoother paste and a better spray mixture will be obtained if the slaking is begun with hot water, and hot water is often necessary where slow-slaking lime is used. If hot water is used there is also less danger of "drowning" the lime. If cold water is

FIG. 12.—Napoleon cherry blossom cluster, showing the stage of blooming when the first spraying should be made.

used, the action should be started by adding only enough water to cover the lime. As the lime begins to slake it takes up water and more must be added. Stir until a paste is formed, then add the remaining quantity of water. If 50 pounds of lime is used, add water to make 50 gallons of stock solution, 1 gallon of which, when thoroughly stirred, then holds 1 pound of lime. After preparation cover the barrels to prevent evaporation, if the material is not to be used at once.

One point to keep in mind in preparing Bordeaux mixture is—never mix strong stock solutions together. Put into the spray tank the right amount of either one of the stock solutions, then run in some water, start the agitator, and put the other stock solution in.

[2] Always stir the stock solution before dipping any out.

If the strong copper-sulphate stock solution is put in first, it is possible to remove the coarse particles of lime from the stock lime solution by washing it through the sieve while filling the tank. The spray tank and pump should be thoroughly washed with clean water after Bordeaux mixture has been used.

LIME-SULPHUR SOLUTION.

Commercial preparations of lime-sulphur solution are usually obtainable on the market. They have largely taken the place of the homemade solutions. The commercial article is reasonable in price, as a rule, and more uniform in strength than the homemade; and spraying is simplified by its use, since all that is necessary to prepare the spray is to dilute the commercial concentrate with the required quantity of water.

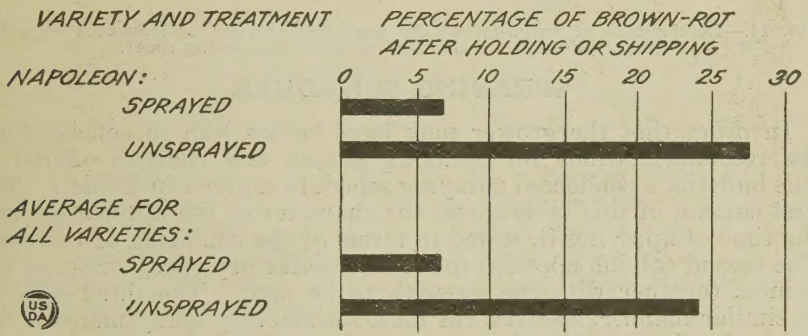

FIG. 13.—Comparison of the average development of brown-rot on sprayed and unsprayed cherries in 18 different holding and shipping tests.

RESIN-FISHOIL SOAP.

Resin-fishoil soap may be made up as follows:

Rosin	5 pounds.
Potash lye (such as is sold for washing purposes)	1 pound.
Fishoil	1 pint.
Water	5 gallons.

Dissolve the resin in the oil by heating in a large kettle. After this has partly cooled, add the potash. Slowly stir the mixture and watch it carefully to prevent boiling over. Now add part of the water and continue the boiling until the mixture will dissolve in cold water. This will require about an hour. Then slowly add the rest of the water and stir the mixture thoroughly. For use, add 1 quart to 200 gallons of spray.

CASEIN.

Commercial caseinate spreaders may be bought, but an equally satisfactory product can be made at home. To prepare a casein spreader, proceed as follows:

Casein	1 pound.
Baking soda	3 ounces.
Water	1 gallon.

Mix the ingredients thoroughly. Let stand for at least an hour before using. To use, add 1 quart of the casein solution to 200 gallons of spray.

If the casein is of coarse granular consistency, substitute caustic soda (ordinary lye) for the baking soda, and put it in the water first. Then heat this soda solution to the boiling point, and add the casein slowly while stirring carefully to prevent formation of lumps. To use the resulting solution, dilute 1 quart to 200 gallons of spray. These liquid casein preparations do not keep well, and consequently no more should be made than will be used for a particular application.

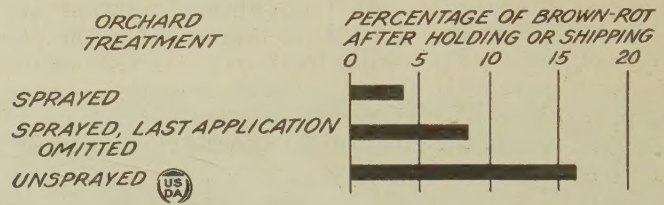

FIG. 14.—Development of brown-rot on the harvested cherries as influenced by a late spray application (about three weeks before picking time).

SPRAYING SCHEDULE.

In order that the grower may have before him in concise form the recommendations for spraying prunes and cherries offered in this bulletin, a condensed spraying schedule is given in Table 1. The first column of this table shows the character of the application and the time of applying it, stated in terms of the condition of the trees. The second column specifies the most satisfactory spray material for prunes, together with the strength to be used. The third column, in similar manner, specifies the most satisfactory spray material for sweet cherries.

TABLE 1.—*Spray schedule for control of brown-rot on prunes and sweet cherries in western Washington and Oregon.*

Application and time.	For prunes.	For sweet cherries.
First brown-rot spray (bud spray). Apply when blossom buds are white and before full bloom. (Fig. 12.)	**Bordeaux mixture, 4–4–50.** **Lime-sulphur, 1 to 50.** Self-boiled lime-sulphur, 8–8–50. Sulphur dust.	**Bordeaux mixture, 4–4–50.** **Lime-sulphur, 1 to 50.** Sulphur dust.
Second brown-rot spray (calyx spray). Apply as soon as most of the petals have fallen.	**Bordeaux mixture, 4–4–50.** **Lime-sulphur, 1 to 50.** Self-boiled lime-sulphur, 8–8–50. Sulphur dust.	**Bordeaux mixture, 4–4–50.** **Lime-sulphur, 1 to 50.** Sulphur dust.
Third brown-rot spray. Apply as soon as husks are shed.	**Self-boiled lime-sulphur, 8–8–50.** Bordeaux mixture, 4–4–50. Sulphur dust.	Lime-sulphur, 1 to 50. Sulphur dust.
Fourth brown-rot spray. Apply two to three weeks before fruit is ripe.	**Self-boiled lime-sulphur, 8–8–50.** Bordeaux mixture, 4–4–50. Sulphur dust.	Lime-sulphur, 1 to 50. Sulphur dust.

The more important applications are printed in heavy type. The more effective and safest spray materials for each application are likewise indicated, where any difference has been shown to exist. A spreader should be combined with the fungicide in each application, particularly the third and fourth. Casein spreaders may be used with any of the sprays above mentioned, but resin-fishoil soap can not be used with lime-sulphur.

This entire schedule is required for complete insurance against brown-rot, and it may be necessary occasionally to put on an emergency application in unusually damp and rainy weather.

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February 27, 1924.

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